

Supporting Cultural Heritage Professionals Adopting and Shaping Interactive Technologies in Museums

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Supporting Cultural Heritage Professionals Adopting and Shaping Interactive Technologies in Museums

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ABSTRACT

Increasingly, cultural heritage professionals (CHPs) (including curators, museum directors, and education officers) are becoming more involved in designing interactive technologies. Specifically, growing access to and availability of digital technology enables CHPs, who may have limited experience with interactive technologies, to create content for and integrate these technologies into their museums. With these developments, there is a growing importance in investigating how CHPs build understandings of these tools in context; this is particularly since curators aim to learn how those tools can support their audiences. In this paper, we highlight how CHPs formed understandings for integrating an interactive tool to support an intended visitor experience into the museum environment through experimentation. Inspired by lessons learned, we propose design recommendations for interaction designers and HCI experts in designing tools and resources that support CHPs to experiment with various ways these technologies could service their interpretation goals.

Author Keywords

Cultural heritage; interactive technology; case study; action research

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

The role that cultural heritage professionals, including curators, museum directors, and education officers, are playing in creating interactive technologies in museums is evolving. Particularly, in HCI, there is an increased interest in providing toolkits and resources for enabling cultural

heritage professionals (CHPs) to create content for, and configure, interactive technologies [16,8,22]. These developments blur the boundaries between the designer, technologist, and the CHP. However, as indicated by much of the existing HCI research in the domain of cultural heritage, integrating interactive technologies in museums requires a great deal of understanding in terms of how those tools can serve visitors in engaging with heritage artefacts and stories [28,15,17]. Thus, investigating how CHPs build new understandings surrounding the ways these interactive technologies can support the visitor experiences they intend to design and addressing how CHPs can be aided in forming these understandings becomes a timely and salient challenge in HCI.

However, HCI research seldom investigates how CHPs discover in what way interactive technologies can support their goals through active experimentation in context and in depth. Indeed, some studies investigate CHPs' involvement in the design of these tools [1,27] and, to some extent, how CHPs build understandings of an interactive tool over time to become effective co-designers [8]. Nonetheless, in these cases, the researchers are the ones who determine the type of experience to design and guide CHPs based on these decisions. In this paper, we reveal how CHPs at a particular museum took control of designing content and narratives to be enhanced by an interactive tool; in turn, we illustrate how they formed new understandings of this interactive tool to aid visitor interpretation and engagements with heritage artefacts. The findings from this study reveal important design considerations for supporting CHPs integrating interactive technologies into their practices in creating and adapting tours, exhibitions, and other museum activities.

This study involved a partnership between the Interaction Design Centre at The University of Limerick and The Hunt Museum in Limerick, Ireland. The first author was, at the time of the study, active as interaction design researcher at the University of Limerick, and also an active volunteer at the museum since February 2013. The second author was the education curator at The Hunt Museum during most of that period. During the study, the CHPs were involved in shaping a portable interactive technology –The Loupe– to support the visitor experience they aimed to design. The Loupe is a magnifying glass-shaped tool for revealing

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stories surrounding museum artefacts. As well as forming the intended visitor experience, the CHPs were also responsible for creating the narrative and the content. As facilitator of the project, the researcher was responsible for supporting the introduction of the technologies, making suggestions for the content, and documenting the design process as it unfolded.

While the museum had a record of incorporating interactive technologies, the participating CHPs had seldom been heavily involved in the design of these technologies and integrating them as part of their practice in forming museum activities. We illustrate here how different methods for experimenting with the tool enabled them to consider different opportunities and challenges in creating and shaping a particular interactive tool to support visitor engagement. Reflecting on lessons learned from this project, we provide recommendations for designing tools and resources that support CHPs in identifying suitable technology and integrate those tools as part of their practices in designing visitor activities. As we argue later in this paper, it would be beneficial if CHPs were supported in building these understandings from the onset of the project. The case study was completed as part of a larger, 4-year project, supported by The Material EncounterS with Digital Cultural Heritage project (meSch) [22] and Irish Design 2015 [13].

DESIGNING INTERACTIVE TECHNOLOGIES FOR MUSEUMS

HCI has a long tradition of investigating how interactive technologies can be used to support visitors in engaging with museum artefacts. For instance, interactive tools have been introduced to enable visitors to make their own interpretive contributions to museum objects. At the *Re-tracing The Past* exhibition held at The Hunt Museum, Limerick, Ireland, visitors were encouraged to record and share their opinions surrounding ‘mystery’ objects within the museum collection [4]. Moreover, museums nowadays are now encouraging visitors to use their own smart devices to form and share their own interpretations to others beyond the museum walls using applications such as Instagram [29].

In addition, interactive technology can be used to support enhanced social interactions within the museum’s walls. For example, the design of the *Ghost Ship* exhibition was intended to provoke surprise, interaction, and chance discovery between groups of visitors [10]. Grinter et al. [7] reveal indicate how audio guidebooks can be designed to support interactions between small groups of people.

Considerations in Integrating Interactive Technologies

As long noted in HCI research, the integration of technology in museums is complex: it requires understanding how those tools can serve the museum, the narrative, and the overall intended experience. As indicated by Hornecker [11], if interactive tools are difficult to use or the interactions are inappropriate, they can distract visitors

from embracing the narrative or engaging with heritage artefacts.

In addition, HCI research has also indicated the impact that the medium has on engaging visitors in museum stories and objects. In a later study, Hornecker [12] further describes how two different installations designed to engage visitors in a dinosaur exhibition provoked diverse responses from visitors. Collectively called *The Jurascope*, one installation included a telescope-like device (the Tele-Jurascope) for overlaying animations on the artefacts in the exhibition; the other installation incorporated a large horizontal screen for viewing animations. While the visitors who used the Tele-Jurascope appeared to be more immersed in the exhibition, those who interacted with the screen were more likely to engage in social interaction.

In HCI, most cases have revealed that the content and technology used should effectively maintain, where appropriate, connections with artefacts, stories, and other people. Some of the design case studies have defined sensitivities and frameworks for supporting visitor engagements using handheld devices [28,25] and static devices [28,5]. In these instances, the authors argue that the interactive technologies, as well as the content provided, should complement each other to support visitor engagement.

The Shifting Role of CHPs in Designing Interactive Technologies in Museums

Indeed, as can be seen from the above literature, the design and integration of interactive technologies require a great deal of consideration. Traditionally, interactive exhibits are created by a team of design experts, technologists, and CHPs. Large museums may have staff in-house with the design expertise to build these installations [17]. In other cases, CHPs may commission the task to external companies that also have the relevant expertise to design interactive technologies for museums. While CHPs may be involved heavily in designing interactive exhibitions in-house, they are usually rather minimally involved in the case of commissioned exhibitions [2].

Within the frame of HCI, there are other approaches for designing interactive exhibitions; for example, through using user-centred approaches, visitors and other stakeholders may be involved as informants of the design [4]. HCI researchers and design experts may formulate design requirements for creating interactive technologies through these approaches. Using co-design, various stakeholders, such as children [23,3], students, and CHPs [14,27], may be involved in the design and integration of interactive tools. However, in these cases, little attention is given to how CHPs build understandings surrounding interactive exhibitions.

There is an increased interest in enabling CHPs to take control of designing interactive tools, thus blurring the distinction between the designer, technologist and CHP

role. In particular, HCI has focused on the development of toolkits aimed to design, for example, augmented reality tools [16], location-based multimedia guides [6], and tangible interactive technologies [22]. However, the focus has been on the usability of these toolkits [6] or on how they are used to construct narratives outside of the context of the museum [16]. The design of such toolkits is no longer done by researchers only; the emergence of commercially available toolkits, such as OpenExhibits [21] for creating multi-touch, multi-user tabletop devices and Tap/TourML [26] for creating virtual tours, increase the opportunities for CHPs to take control of the design of interactive technologies. With the growing interest of involving CHPs in the design of interactive technologies, further emphasis needs to be placed on understanding how curators take control of their emerging role in designing interactive tools to support their intended interpretation goals.

Several co-design studies have focused, to an extent, on learning about the curators' involvement in designing interactive technologies. In creating the digital natives exhibition, Bossen et al. [1] highlight that the curators were inspired by the methods used in the co-design and chose to experiment with them in their own practice. Halloran et al. [8] detail the participation of curators in creating a personalised tour guide experience for visitors. The authors focus on how these curators developed understandings of a particular interactive technology over time through co-design. While this study provides insights into how curators built understandings of this technology, the intended visitor experience has been defined by the researchers coming in; these researchers had the goal of demonstrating to the curators how their tour activities could work differently.

In the above studies, we learn to some extent how curators respond to their involvement in designing interactive tools. However, due to the curators' limited participation in constructing the visitor experience and designing the content in context, little is known regarding the opportunities and challenges that CHPs face when taking control of and building understandings of interactive tools to support their own interpretive goals.

THE HUNT MUSEUM

As mentioned in the introduction, this research involved CHPs working at The Hunt Museum, a small museum that hosts a range of artefacts gathered by a family of collectors. The selection of objects and artworks was not guided by a particular theme, period or culture; rather, the artefacts are a reflection of the interests and curiosities of the collectors. The interpretive layout of the museum was originally designed by the son of the collectors, with the goal of provoking a sense of reflection and discovery in the visitor. Therefore, the objects are not, nor were they intended to be, grouped strictly either thematically or chronologically. In saying that, many objects are grouped into general themes:

for example, Early Christian Art, Bronze Age and Egyptian. In addition, there is little interpretive material in the gallery space: labelling in the museum is kept at a minimal level, so as to encourage visitors to form their own meanings of the collection. For visitors who desire further interpretive information, the museum offers several guided tours to help them comprehend the collection in general, or with a focus on a specific theme.

There are four full-time CHPs employed at the museum. The rest of the staff are volunteers. Some volunteers take the roles of docents, while others are interns. The docents are long-term volunteers of the museum who specialise in a particular activity: this could be delivering tours in the gallery, hosting workshops or trails, or cataloguing the museum's collection. The docents are highly valued because of their knowledge and expertise on the collection. Interns join the museum for 2 - 12 months with a broad but common goal of gaining experience. Interns are selected for their multi-cultural and multi-disciplinary backgrounds: they travel from other countries across Europe and the USA and have backgrounds in a variety of disciplines including museum studies, digital media and marketing. Some interns work in the Care of Collections and Exhibitions department, where they assist the Head of Collections in setting up and administering exhibitions, while others work in the Education Department, where they gain experience in administering, creating and delivering tours, workshops and other education activities in the museum. The museum also regularly hires a marketing intern who is responsible for the museum's promotional activities.

METHODOLOGY

Our project took place over a 15-month period (October 2014 – January 2016). An action research approach was adopted for this study: action research involves an iterative process of planning, acting, observing and reflecting upon a particular change. In this case, the change involved designing a visitor activity in the museum to be supported by an interactive technology. Those conducting action research can observe how change affects a particular situation or environment and adapt their research plans in response to lessons learned [9].

The project described in this paper was divided into three cycles (Figure 1 – next page). Each cycle represents a new iteration of creating and shaping tours to be delivered on an interactive device the CHPs chose. 15 CHPs were primarily involved in creating and shaping the tour assisted by this device called The Loupe. Out of the 15 CHPs, three had, to some extent, experience in creating and integrating interactive digitally enriched exhibitions. These three included two of the curators. As seen in Figure 1, these CHPs were involved at different stages of the project; this was due to their roles in the project and, particularly for the interns, the time of the year when they joined the museum.

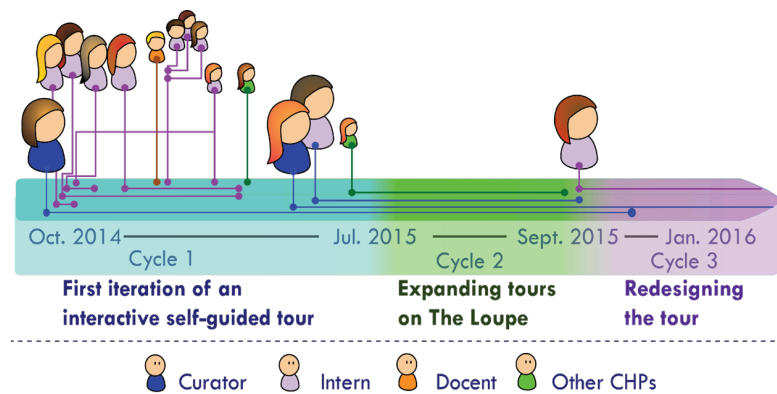


Figure 1. CHPs involved in creating tours for an interactive device during all three cycles

Over the course of the project, 30 meetings were organised to discuss the progress on developing these tours and to agree on the next action points. Participant observation and informal conversations were used during these meetings. The meetings lasted between 19 minutes and 2 hours. During all of these meetings, the researcher took detailed notes that were further elaborated upon once the meeting had ended. Most of the meetings were audio recorded; however, in some cases, on the request of the CHPs or because some meetings were spontaneous and not planned in advance, no recordings were made. The meetings that were recorded were transcribed verbatim.

At the end of the first cycle, the tour was tested internally by 13 CHPs. 17 museum visitors participated in evaluating the tour as supported by the device at the end of the second cycle. Both of these studies involved a mixture of observations of the participants using the device as part of a self-guided tour and interviews directly after the tour. The researcher in the project was responsible for conducting these studies, analysing the feedback, and sharing this feedback with the CHPs for further analysis and discussions.

At the end of the third cycle, the researcher conducted interviews with 12 CHPs who were, in some way, involved in the project in order to gain insights into the CHPs' viewpoints on their involvement in the project. The data gathered is presented in the form of excerpts and vignettes extracted from the meetings and interviews conducted with the CHPs. All names were replaced with pseudonyms.

The CHPs involved in the project were responsible for designing the intended visitor experience: they formed the narrative, the content (using PowerPoint and Google Slides), and chose the interactive device to be integrated. The researcher's role in the project was to suggest software for creating the content, to introduce the technologies and to provide advice on shaping the content.

At the beginning of the project, the CHPs formulated objectives for introducing an interactive tour at the museum. Curator Pascale's intentions for introducing an interactive device were to:

- Enhance the visitor experience by providing content that is not available through other modes of delivery;
- Widen the appeal of the collection; and
- Provide access to the collection to as many visitors as possible.

She specifically opposed introducing an interactive that would provide little to no educational value or was a distraction on the intended visitor experience.

Curator Pascale was interested in providing an alternative avenue for delivering themed tours currently on offer at the museum. These themed tours were designed to enable visitors to learn about the collection from different perspectives. A series of these themed tours are on offer in the museum, including *Queer Tour*, *Gross and Gruesome*, and *Architectural Perspectives Tour*; these tours are delivered either by a docent or self-guided with a booklet. The tour that the CHPs decided to focus on was *The History of Ireland in 10 Objects*. This is a themed tour of the collection that explores the history of Ireland through ten objects, spanning the three floors of the museum.

CYCLE 1: FIRST ITERATION OF AN INTERACTIVE SELF GUIDED TOUR

Upon deciding on the interpretive goals and the kind of experience they wanted to design for, the meetings focused on determining how an interactive technology may be able to complement these goals.

Based on Curator Pascale's intention for supporting a self-guided tour, the researcher presented the CHPs with four interactive concepts that were relevant for supporting their goals; these tools were designed by a multi-disciplinary international team as part of meSch project. They have different functionalities and they are designed to reveal content in diverse ways. The designer presented these concepts in the form of a video [20]; following this, the CHPs were provided with written scenarios that demonstrated how the interactive concept could work to support visitors.

Figure 2A shows The Way Detector, an egg-shaped interactive that follows a hot-cold metaphor: the visitor

holds The Way Detector in her hand, and as she moves closer to the object, The Way Detector vibrates at a faster rate to inform her she is close to an object of interest. When placed on a platform next to the target point of interest, the Way Detector triggers media (such as sound or visuals) on an external device. Figure 2B presents The Plinth, upon which replica objects can be placed. Information is projected from above on each of the six sides of The Plinth. As the visitor moves closer to one of the sides, further information is revealed about the object. Figure 2C presents The Belt. The visitor chooses a theme by placing a card inside the belt. When the visitor is close to a point of interest, he hears an alert sound coming from the point of interest and after that hears a story.

Figure 2D presents The Loupe. Shaped as a magnifying glass, The Loupe aims to instill a sense of discovery and exploration, giving visitors the freedom to see details on objects and unfold layered narratives. It operates through scanning a point of interest, which leads to presenting the first screen of content on The Loupe. The visitor reveals the next screen of content relating to the same point of interest by tilting The Loupe right. Tilting left moves back to the previous content. The Loupe also supports other interactions, such as moving forward and shaking.



Figure 2. The Four Interaction Concepts

In the following excerpt, the CHPs were describing potential interactions that may be suitable for engaging visitors with the museum's objects as part of a tour. At this stage, the CHPs had not seen or chosen the interactive device they had wanted to use for the tour. During these discussions, Pascale was adamant to ensure that the team kept in mind how the actions could enhance visitor engagement and support interpretation:

Curator Pascale: Rather than thinking about an action, interrogate why that action appeals. Some more ideas will be able to come and you'll be able to think of things in a more coherent way across the whole tour.

Following this, Pascale continued:

Curator Pascale: If the story is good and the interpretation is rigorous and has integrity, then everything that descends

from it will also have integrity because its genesis will have come from an intelligent place. If it's 'let's do this gimmicky thing for the sake of having a gimmick, then it's going to feel gimmicky at the time. But if there's something relevant to it... there's that plate in the Captain's Room of the guy who's sort of singing up to the tower lady, what is it about that object that's compelling?

From these excerpts, it appears that the CHPs felt that all interactions were an element of the interpretation and required a great deal of thought. This suggests that understanding the relationship between the interactions and the overall interpretive goals is an important consideration when choosing to integrate new interactive tools into their practice of designing guided tours.

Following this, the researcher presented the CHPs the videos and written scenarios describing the potential interactive tools. In the following vignette, we see the discussion that unfolded after presenting these scenarios to the CHPs. Here, the CHPs focused on understanding the differences between these interactives, and how they may affect the visiting experience:

Intern Mark: The castle you [Intern Nora] were at, where they had all of the interactives in a room and the sounds, that almost adds to the experience. When you're walking in the castle, you could imagine there would be a lot of sound. Whereas in somewhere like this, you appreciate silence to immerse yourself in [looking at] an object.

Intern Leanne: Even then, if [The Way Detector] is vibrating, or if it's giving a heartbeat... would that not be annoying to others? That's a sound as well.

Intern Nora: This is a very quiet museum. There'll never be a huge amount of people in it at the same time in the collection area. There might be a couple coming in off the street and maybe a small group or something... that couple doesn't want to be distracted by the school going around doing sounds or anything. So something like this [looks at The Loupe image on the scenario sheet] this doesn't make sound, does it?

Researcher: No it doesn't make sound.

Intern Nora: This is my personal favourite.

Curator Pascale: It's a nice idea that there is a particular detail like a thumbprint that you can scan an object and that thumbprint would be there and you could say 'thumbprints are often found on ancient objects'...

Through discussing the tools, the CHPs were able to build some understandings on what those technologies could do and how they could support or impede upon the intended visitor experience. As Intern Nora had mentioned, the video really: "brought it to life". The CHPs were able to compare the different tools and discuss their potential in the museum. For instance, the CHPs knew that sound should be kept minimal in the museum. Moreover, Curator Pascale discussed the interpretative potential of The Loupe, highlighting how the action of scanning could be related to uncovering more information about a particular story

behind an object: for example, a thumbprint. This is what attracted the CHPs to The Loupe and drove them to choose this device. This suggests that the CHPs were able to, on some level, discuss how the interactive technology could support the intended visitor experience through viewing video and written examples.

On the initial version of The Loupe, the content supporting the object was triggered by the shape recognition of the artefact. However, implementing object recognition was not appropriate for a self-guided tour of this museum. There are many objects, often small, close to each other and in dimly lit spaces. Therefore, the target content on this version of The Loupe is triggered by NFC tags placed on labels. NFC is wireless communication protocol that enables short distance communication between two compatible devices. NFC tags can store and send information when an NFC-enabled device is very close (typically within 5cm).

However, at this stage, the CHPs felt that further experimentation was required to understand what The Loupe could do to support their goals. For this reason, they chose to reuse and experiment with existing text content that was created and tested already for *The History of Ireland in 10 Objects* tour brochure. Their goal was to experiment with what the tool could do to serve their intended visitor experience. As the CHPs wanted to integrate The Loupe to support a self-guided tour, they decided to add wayfinding to guide visitors to the next object. The CHPs provided the content, which the researcher then arranged and prepared for The Loupe. Following this, the researcher deployed the content on The Loupe. Figure 3 shows a sample flow of content.



Figure 3. Flow of content (cycle 1)

Following the transfer of this content to The Loupe, the tour was evaluated internally in situ by CHPs. While the exercise was brief, this was the first time the tour was tested

on the device from start to finish and in context. Two CHPs (Curator Sarah and Intern Ciara), who had recently joined the project at this time, also participated in the evaluation. Both had the opportunity to familiarise themselves with The Loupe beforehand. However, the evaluation was their first time viewing the content on The Loupe.

As expected, the evaluations with CHPs had revealed challenges concerning how The Loupe supported the tour and the presentation of the content. In particular, the feedback highlighted the need to:

- Further support visitors using The Loupe in scanning the labels;
- Form stronger connections with the objects; and
- Experiment further to better understand the presentation space of The Loupe, in terms of its size, how the content should be designed, and how the narrative should be structured to support the intended experience and narrative.

CYCLE 2: EXPANDING TOURS ON THE LOUPE

Overall, testing The Loupe helped the CHPs to learn the challenges of using this tool to support interpretation and identify potential solutions for shaping the narrative to address these issues. In response, the CHPs were more confident to place further effort in the content. For example, further understandings of the presentation space on The Loupe led the CHPs to explore alternative ways of presenting the wayfinding content. As well as redesigning the floor plans, the CHPs decided to provide written directions in response to the implications of the screen size (figure 4).

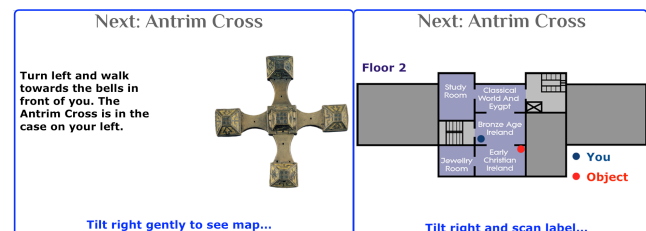


Figure 4. Left – sample written directions; right – sample map.

However, the CHPs felt there was still more to learn and understand regarding what The Loupe could do. In the following vignette, Curator Sarah indicates that she was aware that further work was needed for structuring the narrative on this tool; however, their limited time availability and limited experience in using the device was hindering these efforts:

Curator Sarah: The booklets that you're taking it from - when you read the booklet, it has a picture and a paragraph of text. But when you're here, you're in front of the object and you are getting half of the text and you move on to the other half of the text. So, sometimes it jars. You read this [screen] as one thing and then you go on and you read [the next screen] as another thing. Then you go on and you read

this [next screen] as another thing. So when the information has to go across two [screens], it's the link sentences that need to be worked on properly. It's not a big thing, but it will probably take a bit of thinking about.

Researcher: It definitely takes an awful lot of thinking, because I was trying to look through this content myself and figure out... there's simple things you can do like, "look at X". But I think that's... "you must do this".

Curator Sarah: Yeah, and there's things that we can do here that we can't do with a guided tour, it would be nice in the future to have all of [the images] not to be photographs. That they're just outlines. As you were saying, you've got everything that you need on the screen, so what's the point of them being in front of the object? [...]

Researcher: Or a certain detail...

Curator Sarah: Or a close up [...] There's things that can be taken advantage of [on The Loupe] that I just don't think we've had enough time to really get into because we just don't have enough time. It's literally just a time thing, and using it as well, and the more we use it, the more things we will go "oh, wouldn't it be cool if we did that", getting the interaction between this [the target image] and the object, you know with the shamrock [the target image], lining it up, and stuff like that we could do a bit more with.

Sarah indicated several features of The Loupe could be used more creatively. While she did acknowledge this, her response also indicated that she felt there was more to learn and discover, particularly with relation to the interactive and behaviours supported by the device that could complement their goals in supporting visitor interpretation.

In September 2015, the content on The Loupe was evaluated with visitors; the findings enabled the CHPs to identify further implications of adopting the device in the context of this museum. In the following subsections, we will describe how further understandings gathered from the visitor feedback led subsequently to them shaping their approach in supporting a self-guided tour using a portable interactive tool. The vignettes presented in the following sections are taken from meetings where the feedback gathered from the visitor evaluation was shared and discussed between the researcher and the CHPs.

Responding to Visitor Feedback

One of the main comments shared by the visitors related to the structure of the tour. Particularly, many visitors did not realise the tour they were taking was themed around *The History of Ireland in 10 Objects*. In the vignette below, it can be seen how the CHPs, in collaboration with the researcher, responded to the feedback:

Researcher: I think it definitely needs to be highlighted throughout the tour that this is the History of Ireland in 10 Objects. Because a couple of people, when I interviewed them afterwards, didn't realise it was the History of Ireland in 10 Objects. Even though it was said [on The Loupe] at the beginning.

Curator Sarah: It doesn't go chronologically, doesn't it not? Because [the interpretive layout makes this very difficult to implement]...

Curator Pascale: I have an idea. I mean, this is a lot more design work, what you would want is some sort of...

Curator Sarah: Timeline...

Curator Pascale: Timeline. But you would want to say, 'History of Ireland in 10 Objects' and then you would say 'Object 1' and then you have a circle... you have everything in a trendy circle. Then you scan the object, then the timeline comes up, and it shows you where on the timeline... maybe like '3000 BC'...

Overall, the visitor feedback provided guidance on what further steps to take with the content. In response, the CHPs were more confident in investing further effort into its design and presentation than at the beginning of the project. This suggests that it is important for CHPs to have a good understanding of how the behaviour and functionality of the device affect the presentation of the content and the intended visitor experience they intend to design.

Up until this point, the CHPs felt they needed to further understand The Loupe as an interpretive tool in the context of their museum, particularly in terms of its functionality. When discussing the feedback, it emerged that the CHPs did not see the relevance of the tilting gestures in supporting the experience they intended to design for visitors. In the next vignette, Curator Sarah asked the researcher if the tilting gestures were a relevant feature of The Loupe; she was especially interested in learning what they could do to enhance the content and story:

Researcher: The idea - from the guys who created The Loupe - of using the gestures [the tilting] was so you didn't touch the screen. It is basically part of the discovery process. There's also other features for being able to zoom into different objects, and seeing things from the back [of the objects], for example, having a high resolution image which you can explore, and pan around through it. So there are other options.

Curator Sarah: I mean it's convenient. If this is your design, it is easier to [tilt] than to get involved with the screen. I want to know is it a convenience thing or is it 'ssscchhhhhhhwwwoooo! Forward in time! Zoom in!'

Curator Pascale: If that kind of gesture can be translated into additional content, which is intuitive, like zooming in, then I think it's worth it. If it's a constraint we just have to deal with, that's fine, I agree, we should figure it out.

For the CHPs, it was important that the behaviour of the device and the content complemented each other. The researcher followed by further discussing the intentions of the tilting gestures:

Designer: The idea of having the gesture was so that you didn't have to touch the screen. Basically trying to follow as much as possible the metaphor [of discovery] and going past through content.

Curator Pascale: Right. And the idea of the magnifying glass is that you move it, you don't touch the Loupe.

Curator Sarah: So we need to incorporate [the tilting] into the way that we are presenting our text.

The feedback of the evaluation aided the CHPs in further understanding the opportunities and constraints of the device they had chosen for supporting visitor engagement. In their view, the behaviour of the interactive tool needed to enhance the narrative. To ensure that the content and the behaviour complemented each other, the CHPs felt that the content needed to be shaped further.

Overall, testing The Loupe with visitors provided the CHPs with necessary feedback for understanding how the interactive device could support visitor interpretation. In addition, the feedback helped the CHPs to identify the subsequent steps to ensure the narrative and content was clear. Following this, the CHPs redesigned the tour structure and content in the third iteration of the tour.

CYCLE 3: REDESIGNING THE TOUR

In response to the CHPs' enhanced understandings gathered on The Loupe from the previous iterations, the content had changed significantly. From the CHPs' point of view, the story needed to have a tight structure to support a self-guided tour. In implementing this change, the CHPs had divided the tour into five subthemes (see Figure 5). The CHPs' intention for adding the subthemes was to suggest the experience of moving through different parts of Irish history.



Figure 5. Dividing the tour into five subthemes

While the CHPs were more aware of the opportunities and constraints of the tool, some challenges remained especially since the CHPs felt that its behaviour may pose distractions. It was through actively shaping the content of the tour that the CHPs identified this challenge. For instance, as presented in the following vignette, Curator Sarah was adamant to portray a complex story surrounding a particular painting in the museum. While the story could theoretically be revealed using the tilting gestures on The Loupe, she felt too many tilts would be a distraction:

Curator Sarah: This is the verse from *Romeo and Juliet* from which the title of the [Sean Keating] painting is taken. And this is Sean Keating explaining the title of the painting. So it makes sense to have both of them. But I don't want people to have too many... swinging The Loupe around so there's that as well. Getting enough content in, but not

breaking their arms in a sense. If there's too much content, it's better than not enough because we can take it out.

Researcher: One of the major comments during the [visitor evaluation] was that the text was quite small on [The Loupe] as well. And even though [the text] was bolded as well, you couldn't really see that it was bolded on The Loupe because the screen is quite small.

Curator Sarah: And if we can't have a(n) [animated] scrolling... then it's a case of tilting. We could do a little gif animation of this [points at letter on left of content – figure 6] comes up, then it comes in and then it fades into this quote [points at the Sean Keating's quote on right of content – figure 6]. I don't really know how to do that, which is why I haven't done that! But I know there's a website or something called giphy... which I'm sure, we can learn how to use!

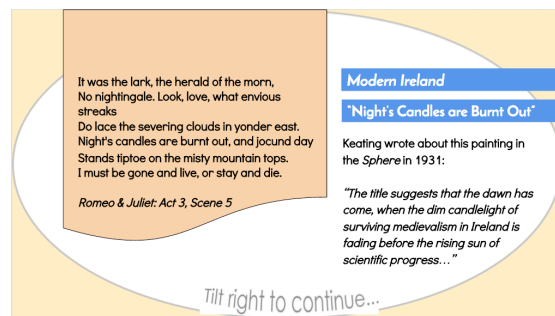


Figure 6. Sarah wanted to present this story on The Loupe

Indeed, the CHPs were limited to the behaviours available on The Loupe. However, further experimentation enabled the CHPs to develop solutions that could help them “workaround” these constraints. In this case, working around these constraints required the CHPs to use skills that they currently did not have: creating GIF animations.

When shaping the content during this cycle, the CHPs felt it was important that they reminded themselves of how The Loupe worked. However, when the CHPs had changed the content, they could not test it on The Loupe directly because they required assistance from the researcher to deploy the content to the device. In her interview, Intern Deirdre describes how simulating the way The Loupe worked with the printed content helped her with further understanding the opportunities and constraints of the tool (see excerpt below). This is similar to the bodystorming method often used in HCI and Interaction Design projects. Deirdre had recently joined the project during the third cycle of iteration of the Loupe-assisted tour. While she had used The Loupe once before, she did not have enough experience to fully understand how it worked:

Intern Deirdre: We printed it [the content] off because it's easy to forget the screens that come and go. So the ones that say like 'tilt right to continue' it's easy to forget that was there. But when you have it on the paper, you have to pretend to do that! Turn it over or something like that!

Researcher: Did you actually pretend to do the tilt [with the paper]?

Intern Deirdre: Yeah! Let me go around to the next one and scan the labels!

[We continued to discuss this, until Deirdre commented]:

Intern Deirdre: Because it gets you into the head of like 'would you do that?' [...] Because, for some of them when we reformatted it, we'd accidentally take off 'now scan the label'. And then when you take the piece of paper around, you'd be like 'ok, now what am I doing?' And in your head you're like 'there's the label; I should be scanning it' but it's not telling you to do that? So you have to be like ok, I need to add that bit back on 'now scan the label'! 'Cause they don't know to do that. And that way [by printing it], we could write loads of notes on and stuff as well, which was really handy when you go back to Drive [Google Slides], because you've got notes... like I wrote all over the first one that I did, just saying like 'this needs to be here, that needs to be added in, this content and this date and stuff needs to be checked'.

Deirdre identified an important consideration when designing tours incorporating novel interactives: it is easy to forget how the interactive works. Specifically, it is important to acknowledge its functionality when structuring the narrative. Through experimentation, Intern Deirdre highlighted that simulating the tour was adequate for gaining further understandings of the way the device could support the intended visitor experience. Noting that Deirdre was new to the project, this suggests that methods for simulating the functionality of the tool may work are adequate for building fundamental understandings of these tools.

DISCUSSION AND CONCLUSION

From the beginning of the project, it was clear that CHPs needed to know how different interactive technologies could support their intended visitor experience. While it is long known in HCI literature that understanding how technology can complement the visitor experience is important [27], little is known about how CHPs build understandings and could be supported in this practice. In this section, we reflect upon the findings presented. We further discuss how Interaction Designers and HCI experts could use these findings for designing tools and resources to aid CHPs in understanding how these tools can help support their goals.

CHPs have interpretation goals that need to be met to satisfy their visitor goals. In this case, when making the decision to use technology in supporting a self-guided tour, the CHPs always referred to what, in their view, the interactive tools were capable of doing and what they could do to complement their goals. Their concerns for integrating these tools into museums were similar to those described in previous studies [17,18]. While CHPs collectively agree that technology should serve a meaningful purpose, the findings from this project suggest that understanding the implications of adopting those tools in context requires further, hands-on experimentation and experience. Thus, to support CHPs as co-designers of

interactive exhibits, it could be useful to provide adequate resources and tools that enable them to engage in these experimentations.

While the availability of toolkits for the purpose of shaping and configuring interactive technologies is increasing (see for example [8,22]), the extent to which they can be reconfigured is limited for those with little technical skill. These constraints may result in CHPs designing workarounds to present the narrative. However, these workarounds could require CHPs to build additional skills (as seen in this case) or make compromises between the narrative they intend to portray and the available behaviours provided by the functionalities of the interactive technology. These points suggest that it is not enough to build these understandings over time once the technology is adopted; the CHPs also need to be given adequate support from the onset of the project to have some understanding of what those tools can do for aiding visitor interpretation. While having this understanding may be considered more important in situations where there is a financial cost for adopting these technologies, a lot of time and effort is required to create the intended visitor experience. Therefore, regardless of the cost of these devices, resources that help CHPs in building these understandings from the onset could help CHPs comprehend what those tools can do for supporting the experience they intend to design for.

In some sense, visual and written scenarios were a useful resource in aiding the CHPs to learn how the tools functioned. On a small level, these scenarios provided some information for the CHPs to identify how those tools could support or impede upon the intended visitor experience and determine whether the technologies could fit into the context of their museum. They may have been able to grasp these understandings because they were clear about the goals they wanted to meet from the onset of the project. By the time CHPs decide to use toolkits to explore different technologies, they may already have some interpretation goals in mind. Many toolkits provide templates to enable CHPs to alter content and reconfigure interactive technologies. Those designing these templates could provide examples (and, if resources are available, video examples) that explicitly demonstrate how the features and behaviours of those interactive technologies could be used to enhance the intended visitor experience. These resources would be beneficial for CHPs to build some understandings on how those technologies can support visitor interpretation.

Nonetheless, visual and written examples may not be sufficient for building adequate understandings of the opportunities and constraints of using those tools for both portraying stories and supporting visitor interpretation. It appears that hands-on experimentation with these tools is necessary to build those understandings, as also recommended by [17,18]. However, beyond experimenting with how the tool physically functions as described by the

above authors, our study suggests that CHPs could benefit from exploring how those tools and their associated behaviours could support different activities in the museum. Providing examples could help CHPs in these experimentation activities, with a particular focus on 1) how different technologies could facilitate the presentation of the narrative and 2) how the features and behaviours of those interactive devices could enhance interactions with the artefacts, stories, and other people.

Due to financial costs, it may not be feasible for CHPs to experiment with the actual technologies. However, encouraging experimentation with low fidelity prototypes could help in building further understandings on how to structure the content and narrative to support interpretation. For instance, bodystorming was shown to be an effective method for visualising the flow of the narrative, as well as identifying and overcoming potential obstacles and constraints of using the technology for supporting visitor interpretation. Indeed, it is possible that CHPs may not be familiar with these design simulation methods, as indicated by Bossen et al. [1]. Therefore, resources could be made available for CHPs to create connections with local designers. These designers could help in facilitating the development and experimentation of these low fidelity prototypes; for instance, they could host design workshops featuring low fidelity prototypes of interactives that CHPs are considering integrating into the activities they offer. CHPs could prepare content in advance. During the activity, the CHPs could be encouraged to enact in context how the content may be revealed using those technologies. CHPs can then shape the content as appropriate. Indeed, this activity could be time-consuming and may require a great deal of time for both designers and CHPs to prepare for. However, we argue that such activities could help CHPs in building necessary understandings of the interactive devices they are considering using without needing to purchase them beforehand.

Nonetheless, it may not always be feasible to have designers facilitating such design sessions. In these cases, it could be useful to provide CHPs with resources to experiment on their own with low-fidelity prototypes using these methods, independent of designers. While providing these resources as part of toolkits may not be practical, toolkits could provide links to already existing resources for assisting CHPs in taking the first steps in creating and experimenting with low-fidelity versions of the tools provided. An example of such a resource was created by the meSch project, one of the projects funding this study [19].

While these tools and resources may be helpful for supporting CHPs in understanding what interactive technologies could do to support their goals, it is important to note that unforeseen challenges could still arise. Without testing the chosen interactive device in context, it would be difficult to determine how it could support visitor interpretation. In saying that, we believe that providing

these resources will help CHPs build sufficient understandings of the implications of adopting interactive tools within the context of their own museums.

We are fully aware that there are some limitations to this research. Due to the scope of the project, which was focused on one small museum, generalisation is difficult. However, we believe these findings could be transferred to relate to CHPs in other contexts. For instance, CHPs need to know how the interpretive tools that they integrate can be used to support visitors in engaging with stories and artefacts. Moreover, here the CHPs chose to focus on a particular kind of narrative experience: a guided tour. As already demonstrated in HCI research, different challenges may emerge when incorporating technology to support other types of experiences: for example, games [15] or free explorations visits [9]. Therefore, the question as to whether these co-design methods could help CHPs in understanding how those tools could aid them in supporting the intended visitor experience remains open. In addition, this case study did not consider that there are various types of museum visitors (such as tourists and specialists); the intended visitor experience was defined the same way for all visitors. However, each visitor type has different motivations and interests, and knowledge [24]. While the goal of this project was to aid CHPs in taking first steps to incorporate new interactive technology, future research could involve identifying different visitor types to formulate interaction concepts and narratives personalised to these different visitor groups.

In this paper, we have discussed how CHPs took control and built understandings of an interactive tool to support interpretation. This study has been inspired by existing HCI research, which focuses on enabling CHPs to create content for and configure interactive technology. Furthermore, we provided recommendations for designing tools and resources to aid CHPs in experimenting with and building understandings of different interactive technologies. Indeed, this study revealed some insights into the challenges of supporting CHPs of shaping and integrating interactive tools into their practices. However, further work is needed to explore possible ways of supporting CHPs in understanding how those tools are relevant for enhancing the experience they intend to design for visitors.

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